THE ROLE OF CLIMATIC FACTORS IN THE DETERIORATION OF IMMOVABLE CULTURAL HERITAGE: A CASE STUDYJANGA COASTAL REGION.

DIGNA F. TILLYA

A PROJECT REPORT SUBMITTED TO INSTITUTE OF AFRICAN STUDIES UNIVERSITY OF NAIROBI IN PARTIAL FULLFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF POSTGRADUATE DIPLOMA IN CARE AND MANAGEMENT OF HERITAGE AND MUSEUM COLLECTIONS.

JUNE 2003

DECLARATION

I Digna Tillya, do hereby declare that, this research project is a result of my own study and findings, except where acknowledged, and that it has not been submitted for a postgraduate Diploma in any other University.

Candidate Signature........tef?! (S^j:,^c A.

Date

Supervisor Signature

Date

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TABLE OF CONTENTS

LIST OF FIGURES 11

LIST OF PHATOGRAPHS 25

ABBREVIATION

BC	Before Christ
C	Century
ITCZ	Inter Tropical Convergence Zone
ICCROME	International Centre for the Study of the Preservation and restoration of Cultural Property
NA	Not Applicable
NGO	Non Governmental Organization.
PMDA	Programme for Museum Development in Africa
RH	Relative humidity

ACKNOWLEDGEMENT

This work is an outcome of research carried out in March to June 2003. Quite number of individuals made possible completion of this project. However due to limited space it is impossible to name them all. In particular I would like to express my thanks to my supervisor Dr. Ephraim W. Wahome, who devotedly supervised the entire research work and provided me with the needed guidance.

I also express my gratitude to Proff Simiyu Wandiba for assisting me in initial preparation of this project. Special compliment goes to the University of Nairobi through Institute of African Studies for granting me opportunity to pursue Postgraduate Diploma in care and management of Heritage Collection.

I wish to acknowledge the material support and financial assistance extended to me by Programme for Museum Development in Africa (PMDA), which enabled me to carry out the postgraduate diploma course. Many thanks to Mr Mubiana Luhila, Mr Mwadime Wazwa for their assistance in carrying out the course and my colleagues at PMDA for their valuable comments and company during my stay in Mombasa.

I am also grateful to Mr D. Kamamba Director, (Department of Antiquities Tanzania) and the Ministry for Natural Resources and Tourism, Tanzania for partial financial support that enable me to pursue this course together with my colleagues of the Antiquities Department in Dar es Salaam for their assistance and moral support.

Lastly but not least, I am gratefully to my families of 'Tilya & Nyaki ' and all my relatives for their excellent moral and material support in my education carrier at the university of Nairobi.

ABSTRACT

The purpose of this study was to investigate how climatic condition leads to the deterioration of immovable cultural heritage along the coast of Tanga. Therefore, study aimed at finding out whether climate was the factor brings about the deterioration of immovable cultural heritage along the coast of Tanga and its influence on the biological and environmental aggressors. The project cover historical building and landscape scenes In addition all the deterioration caused by the climatic condition were identified and recorded together with its cultural and historical properties.

In order to capture the above stated objective the study was guided by the following hypothesis. Coastal climatic conditions lead to the deterioration of immovable cultural heritage. Second coastal climatic conditions do not lead to the deterioration of immovable cultural heritage.

The major findings have revealed that the deterioration of immovable cultural heritage along the coast of Tanga are directly and indirectly attributed to climatic conditions. The climatic agent which include humidity, rainfall, temperature and wind caused decay of wooden construction materials, cracking and splitting of walls due to contraction and expansion. Corrosion of iron sheet, peeling off of wall plaster and falling down of some walls of historic building was also noticed. Furthermore, it became evident that the climatic condition indirectly provided a conducive environment for the growth of plants, microorganism and insect pests leading to deterioration of construction materials on immovable cultural heritage.

With such research findings one can conclude that climatic condition as a natural aggressor play a significant role in deterioration of immovable cultural heritage along the coast of Tanga. However this does not mean diminishing the role of human being. The study therefore recommend for regular condition survey, rehabilitation and maintenance of immovable cultural heritages.

Chapter One

INTRODUCTION

1.1 Background Information

According to Spennemann (2002: 1), cultural heritage are the manifestation of people's interaction with their environment which include people's need for shelter, food and tools, and these are modified through time due to changes in the environment among many other factors. Some of these heritage remains are still in use and some others have been destroyed or abandoned due to transformation of the environment or the way of life. Beautiful immovable heritage like buildings and technical constructions, which were once perceived as artfacts of national pride, may fall apart due to poor maintenance and/or through warfare (Andrew 1998:10).

Immovable cultural heritage consist of various sites ranging from natural caves which were used by man to structures made by man like buildings. Also, immovable cultural heritage varies from perishable construction material (mud or wooden structure) to non-perishable construction material (concrete). For the perishable settlement the artfacts made of durable materials, such as stone tools, iron, potsherds, coins and shell have been excavated to show the settlement of previous ancestors. Some of the immovable cultural heritage have been erected using durable materials. As the result of this, a number of the well-built historical buildings are still in use today for different functions like commercial centres, hospitals, offices, hotels and many other forms.

The immovable cultural heritage in general includes archeological sites, religious sites, graves, palaces, historical towns, historical buildings, rock paintings, cultural landscape, monuments, commercial sites, public sites, infrastructure sites, transportation and industrial sites (Saur 2000:22). Immovable cultural heritage can be grouped into scientific, historic, aesthetic, social or economic values, Spennemann et al (1994:3) and when destroyed cannot be replaced. Spennemann et al (1994: 4) argues that *"every single site is a unique physical manifestation of ideological, technological or social of practice of society concerned. All these elements of a site create a unique record of the past and once destroyed cannot be renewed"*.

The immovable cultural objects have different values such as historic, scientific, aesthetic, social and economic. Scientific and historic values of the immovable cultural heritage include the potential to answer questions through research and archives on the importance of the remains of past ancestors. Thus immovable cultural heritage has historic significance as a record of human artistic messages through the nature of structure and material used for construction. This enhances the messages and values of cultural properties. Each immovable cultural heritage has its beauty which provides a sense of wonder's through its scenery, structure, architecture and the materials used. Social and economic value of immovable cultural heritage depends on its value to the community and its use. Most of the historic buildings are conserved and used for education and tourism. Well preserved and presented immovable cultural heritage can be used as a form of cultural identity for the communities which created them in particular and as a national heritage in general.

Various factors contribute to the deterioration of immovable cultural sites including environmental and/or biological factors. Environmental conditions include climate (light, temperature, pollution, rainfall, humidity and wind), salt, earthquake, erosion, corrosion, abrasion, vibration, storm, hurricane, lightening, fire, flood, tidal wave, and dust. Biological factors include microorganisms, plants, insects and human beings. Factors caused by human being include war, terrorist attack, cultivation, urban development, theft, vandalism, lack of proper legislation, lack of training and ignorance.

1.2. Statement of the Problem;

1.2.1 Research statement

Immovable cultural heritage is of great importance for education, research and cultural purposes when properly preserved and presented. It contains messages, which are used for education and research purposes. The main problem encountered in the pursuit of these goals is deterioration caused by both environmental and biological factors. This project investigated how the climatic condition leads to the deterioration of immovable cultural heritage along the coast of Tanga. This will help to assess the condition of immovable cultural heritage along the coast by highlighting the role of climate in the deterioration of monuments.

1.2.2 Research questions;

- What were Climatic factors that lead to the deterioration of immovable cultural materials along the Coast of Tanga? s
- How does climatic condition cause the deterioration of immovable cultural heritage along the Cost of Tanga?

1.3 Objectives;

1.3.1 General Objective; fluctuation

The general objective of this study is to investigate how the climate along the coast of Tanga leads to the deterioration of immovable cultural heritage.

1.3.2 Specific objectives;

- To find out how climatic factors cause decay on immovable cultural heritage along the coast of Tanga.
- To determine the biological and enviromental aggressors which occur due to climate.

1.4 Justification of Research proposal.

Tanzania is located between longitudes of (29° and 40°) E and Latitude (1° and 11°) S south of equator. It borders the Indian Ocean to the east. The coastal strip stretches from the boundary of Kenya and Tanzania on the northern side and Mozambique to the south. The Tanzania coastal area has immovable heritage sites dating from prehistoric to historic which represent a continuation of the early Indian ocean international trade, a long distance trade that linked coastal areas and the interior areas.

The early Swahili stone town settlements, some in the form of ruins date to the 13^{th} century (Robert 1968: 10-14). The sites became very strategic as a result of participating in the early international trade in the Indian Ocean by exchanging gold, ivory, metals, wild animal products beads, porcelain, cloth and many other items with rest of the world (Clarke 1960:12). The greater parts of these are historical towns and settlements that are still in use today. These include Pangani, Bagamoyo, Kilwa Kisiwani, Mafia Island, Dar es Salaam and Mikindani towns. Other sites found along the coast include Tongoni ruins, Kaole ruins, Kunduchi ruins, Mbweni ruins, Msasani ruins and Mji Mwema.

Tanga region is located on the northeast of Tanzania along the coast. Tanga is a Swahili world, which according to Tanga guide book (1959: 3) means a light from dhows coming to

Tanga town from Persia and India with the North-East Monson. The region has immovable cultural heritage dating from 9th century to 13th Century. These include historic towns and monument built by the Arabs, Swahili, German and British at different times in the past. The region needs adequate protection for these historic buildings and monuments to ensure its cultural significance and its physical integrity. Protection can be legal, physical or moral, and include preventive measures appropriate policy for the development tourism and education activities.

The project results enable one to know the causes of deterioration of immovable cultural sites along the coast of Tanga. It would help to have a legislation and policy, which enhances the conservation of these immovable cultural heritage, monument and sites. Conservation of immovable cultural heritage will ensure their cultural significance and physical integrity are maintained through time for the benefit of future generations.

1.5 Scope and limitation

There are diverse factors contributing to the deterioration of immovable cultural sites. The environmental factors which cause deterioration include climatic fluctuations in rainfall, humidity, temperature and wind among many others. This project was only cover only the climatic condition, responsible for deterioration among the various environmental factors. The climatic factors, which were considered in this study, include temperature, rainfall, humidity and wind. This was because the period for carrying out the research was too short to study all the environmental factors. It may take more than three months to gather the necessary information of all the factors. Also due to financial resources, research was only carried out on few sites. Tanga has more than 64 sites of immovable cultural heritage along the coast (Antiquities Annual report 1997: 35-37) but research was carried out on 36 sites only.

In this chapter background information on the immovable cultural heritage been stated. The statement of the problem has been outlined, the main objectives as well as the scope and limitations have been articulated. The next chapter presents an overview of literature on deterioration of immovable objects.

Chapter Two

LITERATURE REVIEW

2.1 Introduction

This chapter presents a comparative overview of researches that have been carried out on immovable cultural heritages. In addition, the chapter investigates the role of climatic condition on immovable cultural heritage written by the different authors.

2.2 Literature review;

Deterioration in this context can be defined as the alteration of materials that usually leads to a reduction in resistance, increased brittleness, porosity and eventual loss of material due to physical/mechanical and chemical factors (Saur 2000:13). Chemical deterioration occurs when there is alteration of chemical composition, causing damage to an immovable cultural heritage. Mechanical deterioration is used to describe a situation in which a structure has lost some or all of its bearing parts. Damage is usually marked by cracks, crushing, crumblying, breaking, and deformation. Felden (1979: 91) argues that, deterioration of cultural properties is fascilitated by natural and biological factors while Spennemann (1994:13) argues that natural agents i.e. physical, chemical or biological cause the decay of materials and he further argued that climate is the major natural agent responsible for deterioration of cultural property.

Biological deterioration is caused by plants and insects like beetles, moths and termites, which cause damage to timber, and wood structure like roof beams (Pinniger 1994:7-26). Microorganisms, such as fungi, algae and lichens also cause deterioration on immovable cultural heritage. Fungi are simple-celled organisms that do not need energy from light for growth. The fungi bear microscopic spores that are produced in enormous quantities and are always present in the air and spread via air currents. In addition light as part of climatic conditions, is an activate deterioration agent causing fading and aging in a variety of materials by breaking down compounds into base materials.

Deterioration of most of historical buildings due to climatic condition depends on the type of building materials and the method of construction. Most of the historical building including ruins and monuments along the coast were built with coral stone and lime which were used as mortar. According to Maxwell (1995:1) lime has been used in buildings since at least, 5,000 BC. He argued that lime is also used for repairs on buildings. It is preferred to use lime in repair of historic buildings as motor where lime was initial used instead of cement. Lime mortar is permeable and more flexible than cement. Therefore the decay of coral stone may occur due to using of impermeable mortar like cement in repairing as it does not allow water to pass through.

Most of the ruins and historic buildings along the coast are affected by direct rainfall and sunlight, according to Ashurst et al (1998:3) these cause cracking, splitting and spill out the surface of limestone. Torraca (1982:38) points out that rainwater in contact with polluted air forms weak acid which causes deterioration. When it comes into contact with carbonates of calcium and magnesium (mortar and plaster) in rainwater forming bicarbonates which slowly dissolve and resulting peel of wall plaster. Ashurst et al (1999:16) found that the failure of mortar in old buildings is due to lack of maintenance or inadequate protection. Wooden materials rot when exposed to rainwater or high humidity. The dampness causes the fungus to grow on wood and produce acid, which decompose the wood and use the rotten wood as food. Some of the historic buildings like German buildings use iron as the primary construction materials. Ashrust et al (1998:23) point out that in the presence of water and oxygen, untreated iron reacts and causes rust (iron oxide). Salt accelerate the process corrosion in coastal region.

According to Feilden (1979:11) "each component material is best suited to a specific and often limited range of relative humidity and temperature. This is especially, true of materials which are hygroscopic, that is, which absorb and lose moisture relative to immediate environmental conditions. He further argued that such materials can be imagined as functioning somewhat like a sponge, contracting and expanding in response to their water content." This process causes mechanical stresses which result in warping, cracking, splitting and fracturing of walls and result in the detachment or powdering of a painted surface. Ashurst et al (1998:1) argued that, the dampness in historic masonry is due to direct penetration of rainwater, as well as rising damp and hygroscopic salts which cause construction materials to absorb and react with water.

Saur (2000:13) points out that deterioration is due to factors from either natural, social or economic environment, adding that potential weaknesses can range from the lack of legal tools to a competitive or clustered division of work amongst the various disciplines as well as corporate attitude which does not always put continuous care, maintenance and repair as a priority. Also Croci, (2000: 41-51) says that the origin of decay and damage in a new building is due to lack of scientific knowledge, use of constructions beyond their use life, error and imperfection in the original design, environmental conditions and biological factors.

Fungus obtain food from the dead animals and plants and suitable germination of fungus is a moisture content of more than 20% (RH) and temperature between 20-22°C are conducive for food destroying fungi (Ashrust 1999:2). Spennemann (2002;6) observed that natural environmental modifications (such as natural disasters) and natural decay of constituent materials further decreases the resistance of the resource. If these sites are destroyed they cannot be re-created or re-generated in the social and historical context of their original construction. He further argues that, copies can of course be made, but they do not have the same value or context in cultural terms. This argument shows how important it is to carry out an environmental assessment to establish the condition of our sites and to take the necessary action before the condition deteriorates.

2.3 Conceptual framework;

Though there are various agents causing the destruction of immovable cultural heritage along the coast of Tanga, this project investigate the role of climate in damaging and destroying these immovable cultural heritage. The climatic agents, which include temperature, wind, humidity and rainfall, were the main causes of deterioration. They cause destruction on historic buildings and landscape directly or indirectly. Deterioration of immovable cultural heritage along the coast of Tanga are directly and indirectly attributed to climatic conditions. Directly climatic condition causes decay of wooden construction materials, cracking and splitting of walls due to contraction and expansion, corrosion of iron sheet, peeling off of wall plaster and falling down of some walls of historic buildings. Indirectly by providing conducive environment for the growth of plants, microorganism and survival of insect pests which lead to deterioration of construction materials on immovable cultural heritage. Temperature, wind, humidity and rainfall were independent variables while the deterioration was dependent variable.

Conceptual framework(Model)

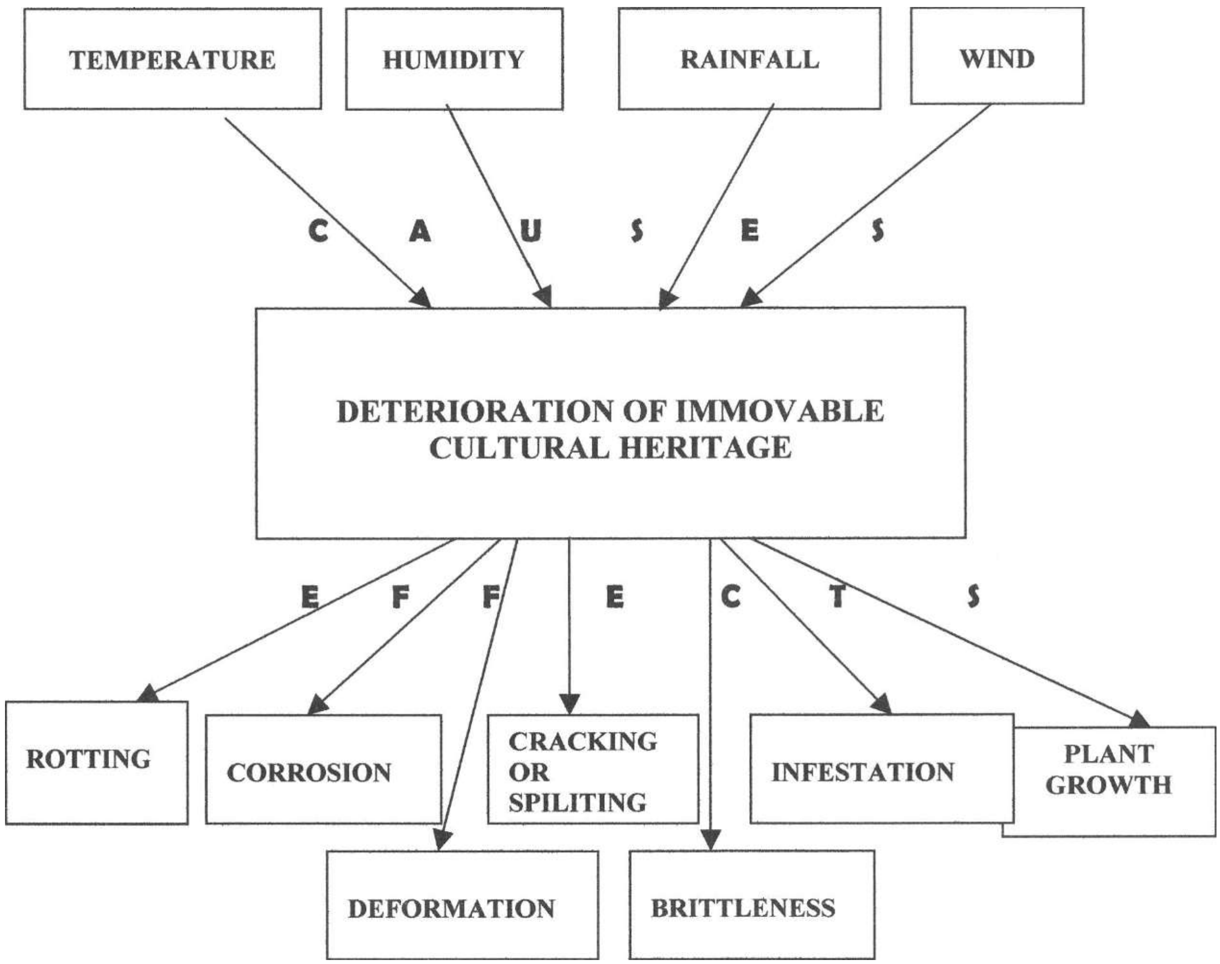

Figure 2.1 Conceptual framework on effect of climatic conditions on immovable cultural heritage along the coast.

2.4 Hypothesis

1. Coastal climatic conditions lead to the deterioration of immovable cultural heritage.
2. Coastal climatic conditions do not lead to the deterioration of immovable cultural heritage.

2.5 Definition of terms.

Balcony: terrace or platform on the outside of a building with access from an Upper floor window or door which are found in Persian or Arab buildings. The design is quite common in modem architectural.

Beam: Long sturdy piece of squared timber, concrete or metal spanning an open room usual to support the structure (Felden 1994:10).

Bricks: Small usual rectangular, block of fired or sun-dried clay or concrete used in building (Ashurst 1996:4)

Climate: the prevailing weather condition of an area or a region over a long time like more than 10 years and in this project it include humidity, temperature and wind.

Conservation: all action taken to take care of immovable cultural heritage and retain its cultural significance that include maintenance, preservation and restoration.

Cultural landscape: In this project landscape include Memorial towers, caves, rivers, residential landscapes, cemeteries and public gardens (botanical gardens and parks).

Cultural significance: Aesthetic, historic, scientific, and social value of immovable cultural heritage for the past, present and future generation.

Deterioration: alteration of material that usually leads to a reduction in resistance, increased brittleness, porosity and loss of material.

Fungi: Any group of unicellular, multicultural and non-photosynthetic organisms feeding on yeast and organic matter (Felden 1994:100).

Historical building: In this project historical buildings include all structures built by our ancestors or invading populations. The building have historical aesthetic and cultural value for the present and future generations.

Humidity: the degree of moisture especially in the atmosphere which contributes to deterioration of immovable cultural heritage.

Immovable cultural heritage: Man made features and structures that are not transferable from their original location and conservation must be carried out *in situ.* example historic buildings, bridges , dams, roads

Lime: White caustic alkaline substance obtained by heating limestone and used for making mortar (Ashurst 1996;2).

Limestone: Sedimentary rock composed mainly of calcium carbonate and used as building material.

Metals: Any class of chemical element such as gold, silver, iron, and tin. They are Lustrous ductile, solid and good conductors of heat and electricity forming basic oxides.

Persians: People from Middle East including Arabs, Hindu, Bohora etc.

Preservation: maintaining the fabric of a place in its existing state through repair to retard deterioration.

Rainfall: a quantity of rain falling within a given area in a given time.

Restoration: Is the process used to reinstate as far as possible the original appearance of existing fabric.

Reconstruction: rehabilitating the structure to its original or near original state.

Temperature: The intensity of heat at a particular place in this case the intensity of heat along the coast of Tanga.

Wind: Air in more or less rapid natural motion. Current wind blowing from one direction to another in a particular place.

In this chapter the overview of researchers who have carried out research on immovable cultural heritage and the role of climatic conditions on immovable cultural heritage have been presented. The conceptual framework upon which this study is hinged has been spelt out as well as the research hypothesis.

Chapter Three

METHODOLOGY

3.1 Introduction

This chapter describes the research site where studies have been carried out and explains the methods used to collect and analyse the data. The tools used are listed and photographs taken from various sites as the evidence of the factors which cause deterioration on immovable cultural heritage are presented.

3,2 Research site: Tanga region along the coast, Tanzania.

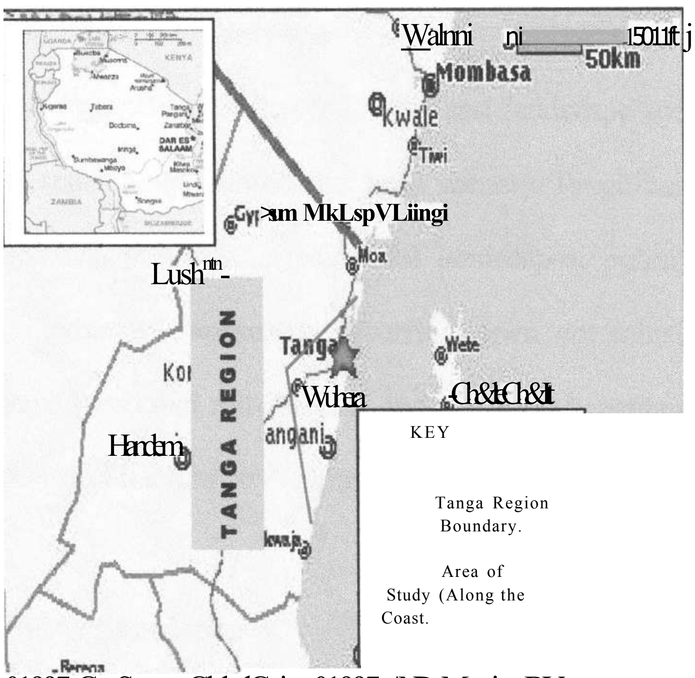

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Figure 3.1: Map showing the research area in Tanga region.

The research was conducted along the Tanga coast in north eastern Tanzania. Tanga coastal strip is about 16 km stretching from the Kenya and Tanzania boundary to the boarder of Tanga and Coast region (Tanga guide 1959:3). The region has immovable cultural heritage found along the coast dating from the 9th century to 13th Century. These include historic town remains built by Persians, German and British buildings, ruins, sacred sites, graves, residence and cultural landscape.

3.3 Research design

The following procedures were undertaken during the research study along the Tanga coast region:

- Observation and recording of deterioration caused by climatic condition on immovable cultural heritage along the coast of Tanga region.
- Identification of causes of deterioration on these immovable cultural heritage.
- Gathering of climatic condition data from the Tanzania Meteorological Agency.
- Compilation and analysis of the data obtained from the field.

3.4 Population or Universe

Tanga region has ancient buildings and landscape scenery. Built scenery includes historic town remains. In addition to built scenery Tanga has landscapes, which encompasses as cemeteries, memorials, residential landscapes, public gardens (botanical gardens, parks, etc.), industrial landscapes (quarries, open cut mines, mine dumps, etc.), road and rail systems (road and railway cuts and dams) and regulated river systems. Streetscapes (trees, houses, architectural styles) dating to the past.

3.5 Study population

The project covers built up scenery and landscape. In built up scenery 30 sites were visited, including the following:

- Traditional houses (Houses built by different tribes along the coast of Tanga)
- Defensive walls (built by different tribes along the coast of Tanga)
- Persian buildings (built by Arabs, Hindus, Bohora and Chinese along the coast of Tanga). The buildings were used for commercial purposes in form of stores, hotels, shops and offices.

- German buildings (comprising government buildings, schools and public town clocks.)
- British buildings.(comprising buildings constructed during the British period)
- Landscape scenery (6 sites comprising public garden, towers, memorial monuments and caves).

3.6 Sampling procedure

Although Tanga region has 64 (Antiquities Annual report 1997; 35-37) immovable cultural heritage sites only 36 historical buildings and landscape sceneries were studied and used as a representative sample of the other immovable cultural heritage along the coast. It was difficult to carry out research on the entire immovable cultural heritage along the Tanga region for the time devoted to this research. The project took almost 14 days of fieldwork research and more than one-month of writing the report. The sites used in this study are generally heterogeneous. As a result stratified sampling was used in order to give each site a chance of being included in the sample. Similar sites like historic buildings, defensive walls and landscapes were combined and later subjected to simple random sampling.

3.7 Methods of data collection

The collection was based on the following steps;

- An intensive was survey carried out on 36 immovable cultural sites along the Tanga coast. All the deterioration caused by the climatic condition was identified and recorded.
- Photographs were taken to capture the evidences of deterioration for analysis and illustrations.
- Information from each site was gathered and recorded in the field form.

- Status of each historical building and landscape was noted.
- Climatic data like rainfall, temperature and humidity gathered from Tanzania Meteorological Agency was recorded.

3.8 Methods of data analysis

The data obtained from the research project was analysed qualitatively and quantitatively. The data obtained through the intensive survey and assessment carried out on immovable cultural heritage along the coast of Tanga was analysed qualitatively by identifying the environmental and biological factors causing deterioration. The climatic data acquired from the Tanzania Meteorological Agency compiled and analysed quantitatively to show how it has contributed to the deterioration of immovable cultural heritage a long the coast of Tanga.

The data was entered directly into recommended computer programs with advantage of speed, efficiency, accuracy and freedom from errors when compared to manual processing. Then the data was manipulated and the information summarized and interpreted. A report was written after analysis of all the data, to show how temperature, humidity rainfall and wind cause the deterioration of immovable cultural heritage.

3.9 Problem encountered and solutions

Tanga has more than 64 immovable cultural heritage found along the coast. Accessibility to some of them was extremely difficult. Due to limitation of time, research was carried out at sites where accessibility was easy. One needs more than three months to carry out research in all the 64 sites. Another problem was to get the previous photographs as supporting evidence to show how the immovable cultural heritage looked like before deterioration.

The Germans and Britons took most of historical buildings' photographs. Therefore to get those photographs from Germany and England was difficult for the time provided for the research. Only a few photographs were obtained from the National Museums of Tanzania.

3.10 Ethical Issues

3.10.1 Research Permit

According to Antiquities Act of 1964 and Antiquities Regulation Rule of 1991 any person or institution, which intends to undertake any research and collection, shall require Antiquities research permit. So the Department of Antiquities in Tanzania granted the research permit for the Tanga region as requested by the PMDA.

3.10.2 Protection of Immovable Cultural Heritage

The immovable cultural heritage in Tanzania is protected under Antiquities Act of 1964 (Act no. 10 of 1964), which was amended in 1979. The legislation provides preservation and protection for archaeological, paleontological, historical architectural, artistic, ethnological and scientific interests. The 1964 and 1979 Acts define a monument / or immovable cultural heritage as:

- *any building, fortification, interment, midden, dam or any structure erected, built or formed by human agency in Tanganyika before the year 1863, and*
- *any rock painting or any immovable object painted, sculptured, carved, incised or modified by human agency in Tanganyika before the year 1863; and*
- *any earthwork, trench, well, cave, tunnel or other modification of the soil or rock dug, excavated or otherwise engineered by human agency in Tanganyika before the yearl863.*

The Acts also gives the Minister responsible for the Antiquities authority to declare a monument and conserved area after some procedures are followed. By notice in the gazette and after consultation with the Minister for the time being responsible for lands, to declare a conservation area or site which:

- *In his opinion is a valuable national heritage for its aesthetic value; or,*
- *Contains a homogenous group of monuments;*
- *Contains buildings, structure or other forms of human settlement, which are valuable national heritage for their historical, architectural, or cultural value.*

Also, there is a Cultural Policy, which administers and controls all forms of cultural heritage. The cultural policy (1997:8) states that "all the man-made objects shall become national monuments on attaining the age of one hundred years".

3.10.3. Community participation in conservation of immovable cultural heritage

In Tanga there is an NGO (Non Governmental Organization) which is responsible for the conservation and promotion of the heritage of Tanga. This NGO is known as URITHI, it is a Swahili word which means heritage.

This chapter outlines the steps followed during the fieldwork, data collection and analysis. The methods that were used in the collection and data analysis have been explained as well as the problems encountered including the research and ethical issues. The next chapter presents the findings from the field.

Chapter Four

THE ROLE OF CLIMATIC FACTORS IN THE DETERIORATION OF IMMOVABLE CULTURAL HERITAGE.

4.1 Introduction

This chapter gives an outline of some climatic parameters representative of the coastal areas in Tanga region proposed to influence immovable cultural heritage sites in the area. A listing of surveyed immovable cultural heritage sites to facilitate this research study is also included and presented in form of tables, graphs, charts and photographs/plates.

4.2 Climatic Profile of Tanga along the Coast

This section presents meteorological data obtained by courtesy of Tanzania Meteorological Agency for Tanga Airfield representative of the coastal strip. The airfield is located at latitude 5.05°S and longitude 39.04°E and at an elevation of 48 metres above mean sea level. Tanga coastal areas experience tropical climate generalized as hot and humid with daily and seasonal variation in temperatures and humidity. The climate of the area is determined to a great extent by the movement of the rain belt, better known as the Inter Tropical Convergence Zone (ITCZ), which-responds to the apparent movement of the overhead sun north and south of the equator. This gives way to two rainy seasonal experienced between March - May (long rains) and October - December (short rains). The average annual rainfall ranges from less than 50 millimeters (mm) in February to about 300 mm in May as shown in Figure 4 3. Peak rainfall, as shown in Figure 4.3, is attained in May and November. Annual variation is remarkable as is shown in figure 4.4.

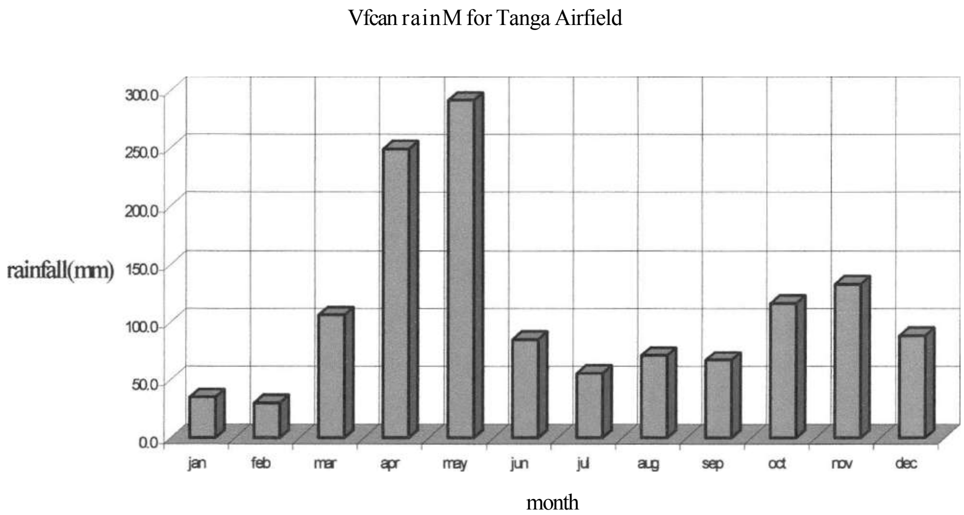


Figure 4.1: Mean monthly distribution of rainfall at Tanga airfield

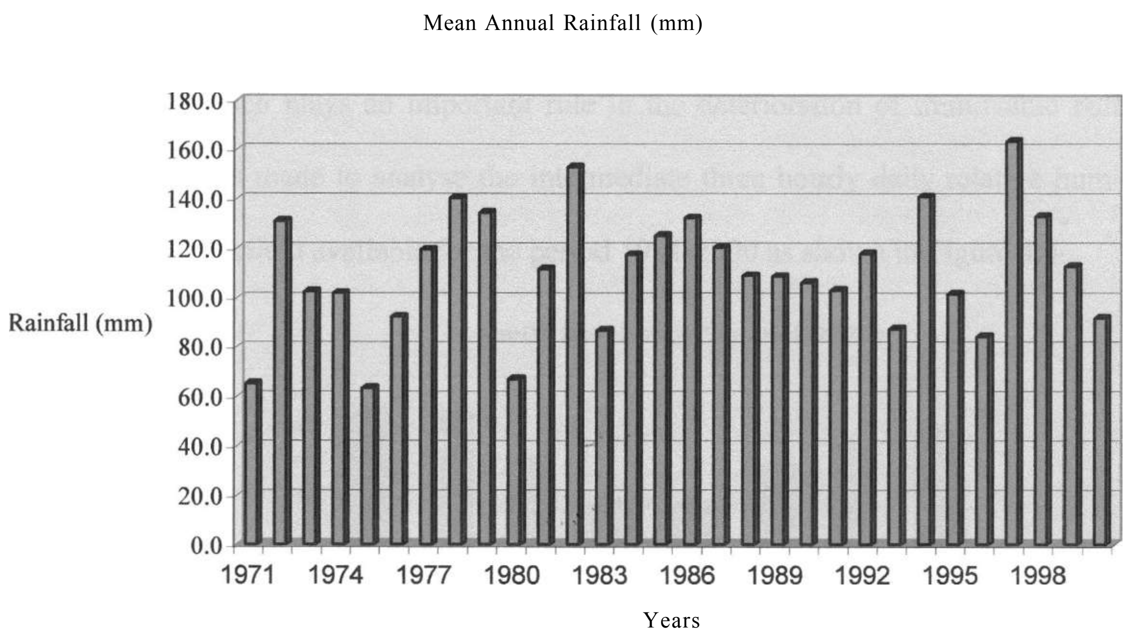


Figure 4.2: *Mean annual distribution of rainfall at Tanga*

Figure 4.3 shows the average monthly temperatures. It ranges from 24°C to over 28°C and the annual variation is different from one year to another depending on prevailing weather conditions. Extremes of up to 31 °C may be encountered during dry spell months in January and February.

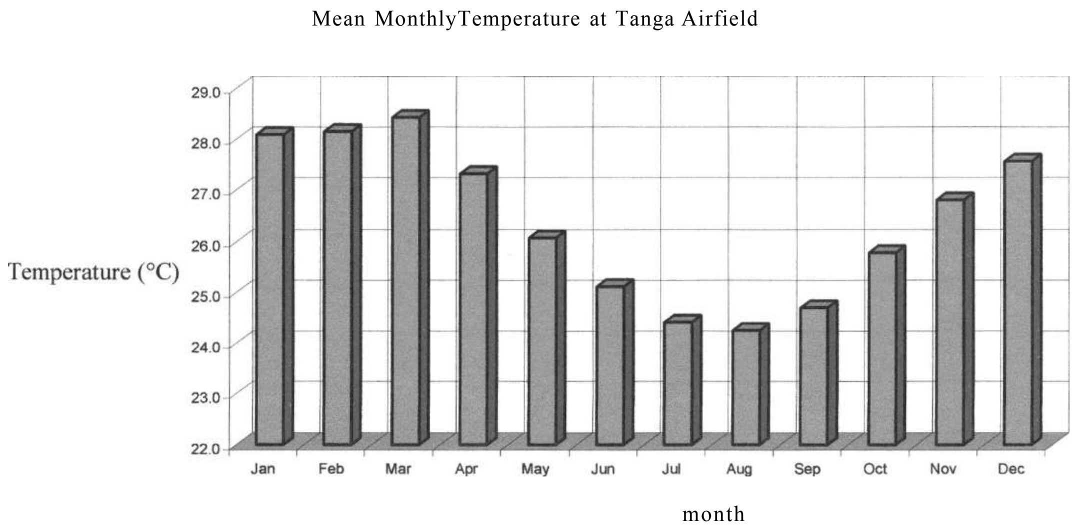


Figure 4.3: Mean Monthly Temperature at Tanga Airfield

The study also deals with relative humidity, an important climatic parameter reflected in many findings, which plays an important role in the deterioration of immovable cultural heritage. Effort was made to analyse the intermediate three hourly daily relative humidity data from Tanga Airfield available for the period 1991-2000 as shown in Figure 4.4.

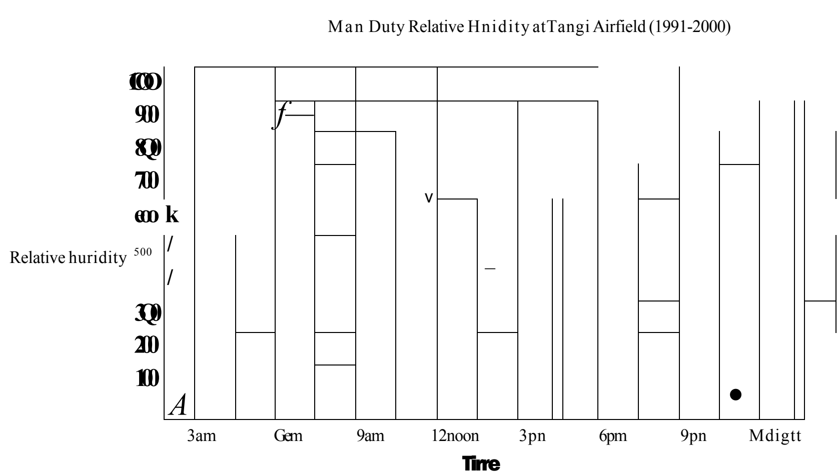


Figure 4.4: *Mean daily relative humidity at Tanga Airfield*

On the average, maximum relative humidity is about 90% usually attained in the morning hours and decreasing to a minimum of about 60% in afternoons as shown in Figure 4.4.

Further exploration using anomalies of the relative humidity at the three hourly intervals

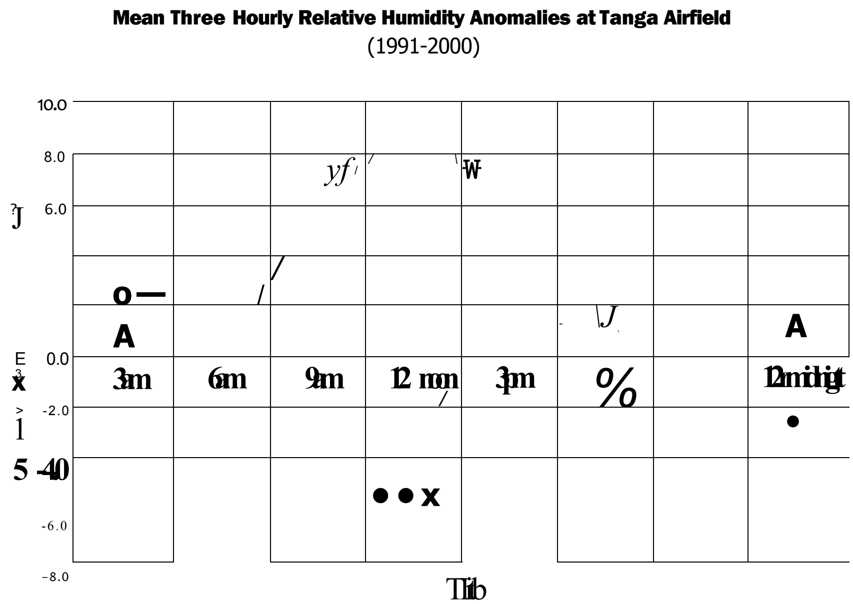


Figure 4.5: Mean Relative Humidity anomalies at extreme months

were made during the hot and driest month (February), wettest months (May and November) and coolest and driest month (August). The results are illustrated in Figure 4.5. The anomalies were simply obtained by subtracting mean records from actual records. The analysis shows that values of relative humidity anomalies are below 0.0 or below the expected threshold during the hot and diy month of February meaning that moisture is deficient at this time of the year along the coastal areas. Moisture is also generally deficient during the coolest period along the coast in August. During these two months, relative humidity is lowest in the morning at 9 am. On the other hand, moisture is above 0.0 or above the expected threshold or surplus during the wet months. Surplus moisture is thus common during the months of May and November. Values of more than 8% are commonly observed during midday in May. As noted in figure 4.1, May and November are the months with peak rainfall during the long and short rains respectively.

Information on wind was also available from Tanga Airfield. It consisted of surface wind frequencies compiled for 10 years in the period 1990 and 1999. The information conspicuously shows variation of both wind direction and speed for the morning and afternoon sessions as outlined in the 16 individual points of the compass representing direction and respective strengths. In between October and February, the dominating frequencies indicate the winds to be blowing from the north or northeast can closely be linked to the northeast monsoons. The dominating surface wind frequencies also had a southerly orientation during the months of May to September related to the southwest monsoon winds.

4.3 Immovable cultural heritage

4.3.1 Historical buildings

An intensive survey for this study involved visits to 36 historical scenes along the Tanga coastal areas. The scenery included historical buildings of which some were defensive walls, ruins or historical buildings built by Persians, Germans or Britons. Some of buildings were administrative offices, shops and residential houses. Among the 36 sites some were landscape sceneries, which included public gardens, towers, memorial monuments and caves. This research also targets traditional houses built by various tribes in and around Tanga. Historical buildings, according to Felden (1994:1) give people a sense of wonder which causes them to want to learn more about the origins of buildings and their builders. Buildings portray the history of Tanzania and in particular Tanga, before, during and after colonialism. Deterioration of most of the historical buildings depends on the type of building materials used and the way they were constructed. Different ranges of deterioration have been observed as discussed below.

4.3.1.1 Traditional houses

Traditional houses in Tanga along the coast were mainly built using wooden poles, plastered by mud and thatched by grass (Plate 4.1). Traditional houses were built along the coast of Tanga by the local tribes including Digo, Bondei, Ngazija, Segeju, etc. These traditional buildings were not long lasting and durable due to the materials used in building them. In spite of this, they had an advantage of being environmentally friendly and cheap to build.

Plate 4. 1: Traditional house (Kichalikani)

The traditional houses needed frequent maintenance and several of these buildings were very much affected by weather and climate. As such a routine for the owners to renovate the traditional houses after the end of every rainy season was necessary. The durability of traditional houses depended on location, technology and the material used. Those built on dry areas lasted for a longer time compared to those built in wet areas like along the coast where rainfall is abundant throughout the year and humidity is always high. On the other hand, houses built using coral stones and lime persisted for longer times in comparison to traditional houses.

4.3.1.2 Defensive walls

It was noted during the visits that each tribe had defensive walls built around their houses. Digo, Bondei, Ngazija and Segeju built the defensive walls purposely to defend against the tribal wars (Plate 4.2 ,4.3). The main rivals were the Maasai during the 19th century (Mturi 1975. 14).

Plate4. 2: Kwale defensive wall without Plaster

Plate 4.3: Chongolian defensive wall and peeling off of wall Plaster at the lower part of the wall

Plate 4.4: Deterioration due to climatic condition. Part of Chongolian defensive wall

A survey conducted at Mwarongo, Kwale, Kizingani, Kichalikani, Chongoliani and Pangani shows that these walls still exist. Most of the defensive walls were built by using coral stones and limestone. It is unfortunate that a large part of the walls in most locations are now seriously deteriorating due to environmental conditions (Plate 4.4). Direct rainfall, high humidity as well as temperature contrasts caused by direct sunlight during the day caused expansion and contraction of construction materials as a result of which cracking, splitting, peeling off of plaster were observed (Plate 4.4). Moss, fungus, algae, lichen and higher plants which lead to collapse of some of the defensive walls through large roots were also noted to play role in the deterioration process during the visit.

4.3.1.3 Ruins

Persian traders were among the earliest outsiders to visit Tanga. It is believed that Persians including Arabs, Hindu and Bohora merchants from the Middle East Asia first came to East African countries for trade during 9th to 13th century (Chami 1994:26, Sutton 1970:10). They contributed in establishing the town between 13th to 15th century (Clark 1960:10 to 30). Tanga is a Swahili word which somehow relates to the light from dhows coming to Tanga town from Persia. The dhows were not like the modern motor driven boats, instead they were powered by the famous monsoon winds.

Plate 4.5: Tongoni ruins very fragile, some of the walls have a lot of cracks and peeling off of plaster.

The North-East Monsoon winds brought the dhows to Tanga from Asia and the South West Monsoons moved them back (Tanga guide 1959; 3). Ruins, which included tombs, mosque and residential houses, are some of the historical sites built by the Arabic traders. (Chitich 1974:22-24). The ruins were built using coral stone obtained from dead coral reefs and lime mortar (Chittick 1984:13; Plate 4.5, & 4.6 above). It was noted that most of the ruins found along the coast of Tanga were not roofed. The ruins were very fragile due to deterioration as a result of weathering and old age (Plate 4.5 and 4.6). Most of the ruins are known to have a lot of splitting, cracks on the walls, peeling off of wall plaster, with some having

Plate 4.6: Cracks caused by plants at the Kwale ancient mosque.

fallen down of their pillars (Plate 4.5, & 4.6). Growth of small and higher plant mosses, fungus, grasses, and the like was also noted on some ruins (Plate 4.5 and 4.6).

4.3.1.4 Taiiga Swahili Historical buildings

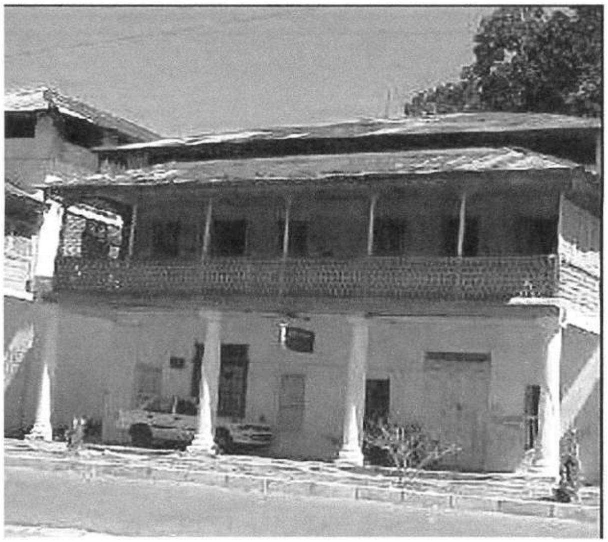


Plate 4.7: Persian Building with balcony and its roof was highly corroded due to high humidity and salt

Some Swahili or Persian historical buildings were in good condition due to regular maintenance. These included the temples and mosques. Some of them were in a very bad condition especially in Pangani district where buildings have undergone deterioration due to climatic conditions (Plate 4.9).

The roofs were highly corroded due to salt and high humidity (Plate 4.7 & 4.8). The holes found on the iron sheet cause rainfall water to penetrate into wooden rafters. Rain water, which penetrate into iron sheet causes high dampness which as the result destroys the wood (Plate 4.8).

Plate 4. 8: highly corroded roof, Bohora building, Tanga

Plate 4.9: Slave building, PanganUPeeling off of walls, cracks and growth of vegetation due to climatic condition effects.

The rafters, balconies, doors and window frames consisting of wooden construction material have decayed tremendously due to dampness, which provides a suitable environment for fungi growth (Plate no 4.9). Walls have severe cracks, splits and peeling off wall plaster while some of the building walls have disintegrated due to weathering (Plate 4.9).

Furthermore, infestation by subterranean termites was observed on the walls and windows of buildings in the form of off brown mud-like materials or tubes, with line walls and wooden material. These have caused destruction on the walls and windows (Plate 4.10 &4.11).

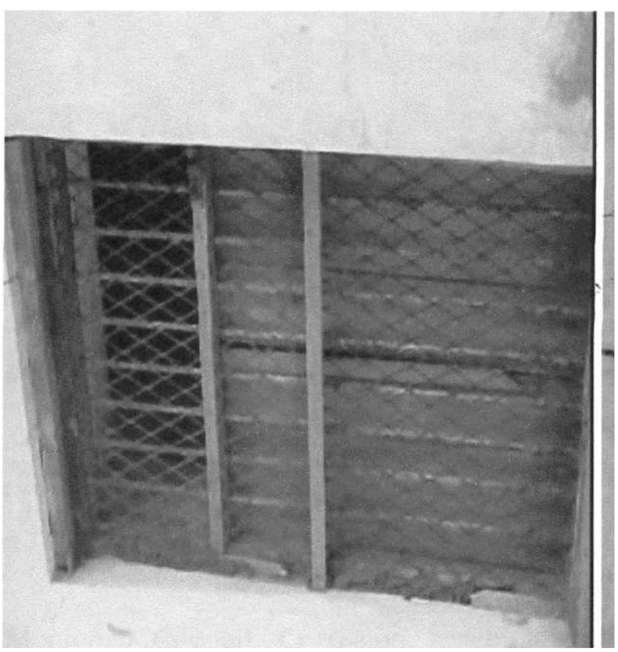


Plate 4.10: Corrosion of iron and termites on window (Bohora building), Tanga.

Plate4. ll:Cracking on wall caused by termites (Bohara building). Tanca.

4.3.1.5 German buildings

The Germans ruled Tanganyika between 1885 and 1918. During this period they took over the whole of Tanga region (Clarke; 1960 91-103. During the time various buildings were built for different purposes like the administration blocks (Bomani), hospitals, schools, railway lines, residential houses, shops, markets, etc. The survey carried out on several of these sites noted that all of the German buildings along the coast were made of thick walls built using coral stones and lime as mortar (Plate 4.12).

The materials used were obtained locally. Walls were plastered white. In some buildings floors consisted of coral blocks laid out by rafter and mangrove poles. The German administrative buildings housing the government offices were of the German classical architecture with mixed with some islamic influence.

Plate 4.12: Front view of Cliff block,, deterioration caused by climatic condition (Growth of plant) On the left there was extension of new building.

This was noted at the Tanga German Boma (former regional block), Pangani German Boma (Administrative building) and the Cliff block housing a hospital. The general condition of most of the German buildings was not impressive despite the fact that there was a non-governmental organization charged with the responsibility of taking care of all historical buildings in Tanga Municipal Council. Corrosion, cracking, splitting and peeling off of wall plaster was desperately noted on most of these buildings. Growth of plants on the roof and walls was also observed (Plate 4.12).

Microorganisms like fungus are commonly observed over the decayed wooden materials like rafters, arches, doors and window frames

Plate 4.13: Peeling off of wall due to climatic condition [cliff block/

{Plate 4.12,4.13 and 4.14}.

The plant growth on the roof causes leakage, which in turn lead to the deterioration of walls inside the cliff block (Plate 4.14). Additionally, infestation by subterranean termites was observed on German buildings. It is clear from the presence of brown mud-like materials or tubes, which line the walls.

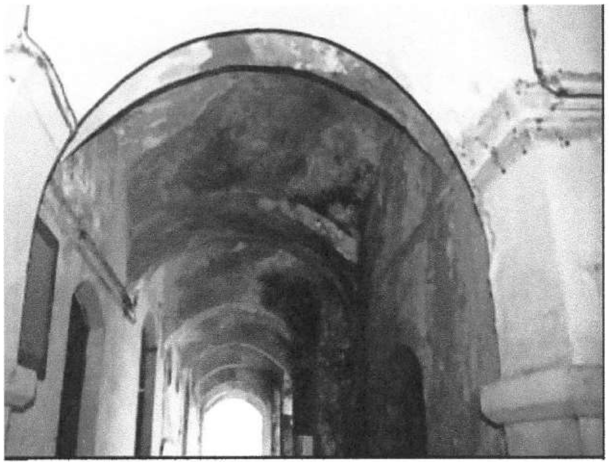


Plate4.14;Peeling off of wall plaster inside the cliff block due to climatic conditions (Bombo hospital).

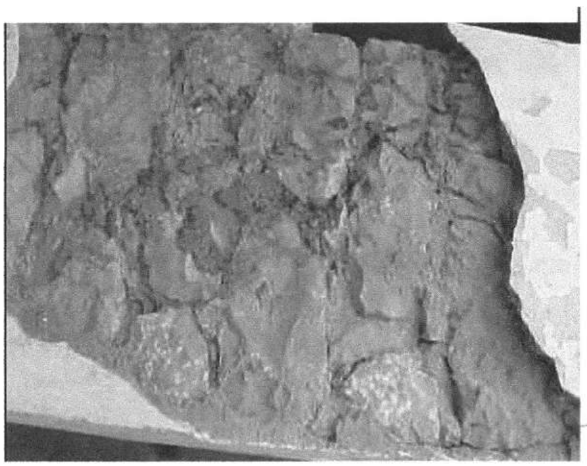


Plate 4.15;: Termites on the wall cause the peeling of wall plaster (Health building)

The presence of termites cause the peeling off of wall plaster as shown on (plate 4.15) In some buildings like the former Tanga sec. school which now serves as a health institute,

Plate 4.16: Peeling off of wall plaster and painting at lower part of building due to climatic condition effects, (health Building)

it was observed that the peeling off of wall plaster was caused by the hygroscopic water. Which means that the water moving upward to the building material through capillary action causes the peeling off of wall plaster (Plate 4.16).

4.3.1.6 British buildings

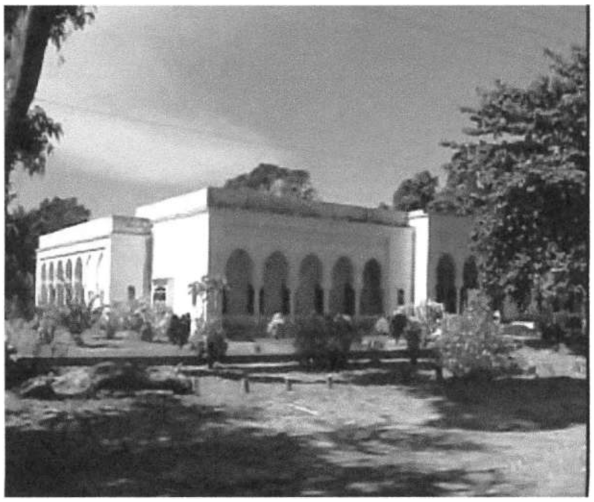


Plate 4.17: Tanga library built during the British period it was in good condition.

The British ruled Tanganyika after the first world war (Clarke 1960; 11). They took over most of the German buildings like the administrative buildings. New buildings dating to the British colonial era in Tanga include Mkonge hotel and the Tanga library. Like the Germans, the British used coral stones as building materials and lime as mortar. These two buildings are still in good condition except for few cases. Weathering appears to be the main factor affecting these buildings and it will turn worse if deliberate measures are not taken to contain this.

4.3.1.7 Landscape

Research was carried out at landscape sites. It was observed that all were in good condition except on a few cases like the German tower which was covered by grass and cracks on the lower part (plate 4 18). The cracks may have been caused by the underground water or direct rainfall and sunlight.

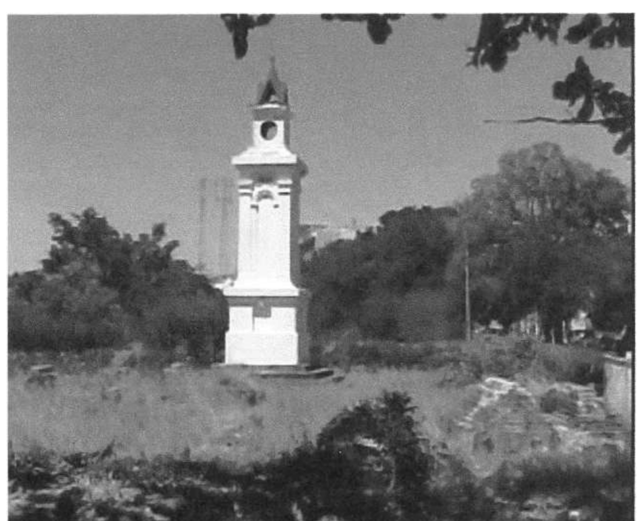


Plate 4.18; on the right side, shown grass growth on German tower and graves-

On the Second World War German landscape , the colour of the board with the names of people who were involved in war was fading out (plate 4.19). The fading of colour was caused by direct sunlight.

Plate 4.19: On left side shows fading of colour on a board with German second world war names/burials

Amboni caves are a geomorphologic feature of great scientific interest as well as awe-inspiring and impressive to visit.

The caves have been developed in the Tanga Limestone series, which is of Jurassic age, and is estimated to extend over an area of 234 kilometers. Human beings through vandalism caused damage to Amboni caves by adding graffiti outside and inside the cave (Plate 4.20).

Plate 4.20: Graffiti on worship place inside the Amboni caves.

Figure 4.6: A summary of deterioration evidence on immovable cultural heritage sites visited in Tanga.

	TYPE OF SITE	TYPE OF DETERIORATION	POSSIBLE CAUSES
1	Defensive walls	Cracks, splitting and peeling off of walls	Expansion and contraction of walls due to high temperature from direct sunlight, high humidity and direct rainfall or acid rainfall.
		Abrasions, peeling off of wall plaster and collapse of some walls	Wind, rainfall,
		Plant growth (Moses)	High Humidity, rainfall and warm temperature
2	Ruins (Mosque, residences and Tombs)	Cracks, splitting, Peeling off of wall plaster on the walls of mosque and graves.	Expansion and contraction of walls due to high temperature from direct sunlight direct rainfall or acid rainfall and high humidity
		Top part of pillars have fallen	Wind, rainfall,
		Mosses and lichen on the walls	Conducive temperature, high humidity and rainfall
		Abrasion, peeling off of wall plaster	Wind, expansion and contraction of walls due to high temperature from direct sunlight direct rainfall.
3	Swahili/Persian historical buildings	Corrosion on aluminium or iron sheet.	High humidity, rainfall, Wind with salt moisture
		Rotten wooden rafters, arches, dooms, doors and window frames.	High humidity, warm temperature and rainfall,
		Cracking, splitting, peeling off of wall plaster on walls and beams .	Expansion and contraction of walls due to high temperature, high humidity, acid rainfall, salt, and direct rainfall
		Growth of fungi on decayed wooden construction material like rafters.	Conducive environment with warm temperature, high humidity and rainfall
		Growth of vegetation on walls and roofs.	Conducive environment with warm temperature, high humidity and rainfall
		Infestation on wooden construction material and walls.	Conducive environment with warm temperature, high humidity and rainfall
		Growth of mosses on walls which cause decay peeling off of walls plaster.	Conducive environment with warm temperature, high humidity and rainfall.

4	German historical buildings	Corrosion on aluminium or iron sheet.	High humidity, rainfall, Wind with salt moisture
		Cracking, splitting and peeling off of wall plaster on walls and beams.	Direct penetration of rainfall, acid rainfall, rising damp through capillarity process), high humidity, hygroscopic salt and expansion and contraction of walls due to high temperature
		Growth of vegetation on walls and roofs.	Conducive environment with warm temperature, high humidity and rainfall
		Growth of fungi on decay wooden construction material like rafter.	Conducive environment with warm temperature, high humidity and rainfall
		Rotten wooden rafter, arches, doors and window frames.	High humidity, warm temperature and rainfall,
		Infestation on wooden construction material and walls.	Conducive environment with warm temperature, high humidity and rainfall
		Growth of mosses on walls which cause decay and peeling off of walls plaster.	Conducive environment with warm temperature, high humidity and rainfall.
5	British buildings	Peeling off of wall plaster on walls.	Direct penetration of rainfall, acid rainfall, salt, high humidity, wind with salt moisture and high temperature.
		Corrosion on aluminum or iron sheets.	High humidity, rainfall, wind with salt moisture
		Corrosion on Sir King George memorial statue	High humidity, rainfall, wind with salt moisture
6	Landscape (Public gardens, caves, memorial towers, graves and burials)	Vegetation growth on some of gardens like German memorial tower	Conducive environment with warm temperature, high humidity and rainfall
		Cracks, splitting and spilling of construction material on walls	Vegetation and expansion and contraction of walls due to high temperature, high humidity and direct rainfall
		Fading of the colour on boards with memorial names	High humidity, rainfall, wind with salt moisture

In this chapter data has been described with use of graphs tables and photographs. The climatic data has been used to illustrate its effect on immovable cultural heritage and photographs. The foregoing chapter discuss the effects of climate on immovable cultural heritage''

J S I f t S ^ »

Chapter Five

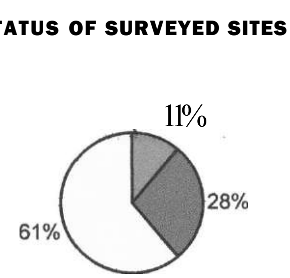
DISCUSSION

5.1 Introduction

This chapter discusses the data on immovable cultural heritage derived from the coast of Tanga. It gives a general assessment of the role played by climatic factors in the deterioration of cultural materials.

5.2 Status of immovable cultural heritage along the coast of Tanga

The status of the immovable heritage sites derived out of the research study are presented in a pie chart as shown below (figure 5.9) to categorize them into three categories; bad, fair and good. The categorization process showed that 61% sites were in a bad condition. 28% were in fair condition meaning that they could be improved through repairs. Out of the whole bulk only 11% were in acceptably good condition. These included landscape sites and buildings dating to the British colonial era.



• Good •Fair DBad

Fig. 5.9; Chart shown the status of sites where the research carried out.

It was observed that deterioration in all the cases was directly or indirectly related to climatic conditions. This involved all the ruins, defensive walls and the historic buildings plaster and in some instances walls had collapsed, It is known for sure that indirect climatic conditions provide conducive environment for plants and insects to survive on immovable cultural heritage as a source of food. Some of the plants and insects produce acidic agents which destroy the monuments in the long run. Parasitic plants were also found to grow on some historic buildings and thus getting their nutrients from such buildings.

5.3 The effect of climatic factors on immovable cultural heritage.

5.3.1 Temperature

Incoming solar radiation received on the surface of the earth as sun energy heats among others the immovable cultural heritage sites in Tanga directly or indirectly. The daily temperatures along the coast of Tanga range from 24°C to 29°C. The heating process on the immovable cultural heritage sites has an impact on the construction material as they expand and contract. Over many seasons and years this may lead to cracking, splitting and peeling off of walls making up the cultural heritage. Suitable temperatures provide a conducive environment for insects to complete their life cycles. Most of them breed and develop rapidly at the temperature of 25°C and slowly below 15°C. Pinniger (1994; 36) has also shown that insects can also survive outside this temperatures range i.e. from -18° C to 40° C. Insects like termites and beetles breed very quickly in unattended structures like the immovable cultural heritage. As the temperature in Tanga falls within the most suitable range for insects' development, insects like subterranean termites were commonly found roaming in most of the historic structures surveyed.

In addition, suitable temperature provide a conducive environment for parasitic plants and other microorganisms such as bacteria, fungi, algae, mosses and lichens to grow. Microorganisms like fungus obtain food from dead organic materials like plants and animals. The optimum temperatures for most wood destroying fungi is known to be between 20°C and 25°C (Felden 1994: 132-133). The temperature range in Tanga thus provides a conducive environment for such microorganisms and plants to survive. A mass of threads was seen destroying wooden materials such as beams, arches, vaults and door domes (Plate 4.9). Presence of green algae and moss were conspicuously visible on a majority of old buildings and other structures. There is no doubt they caused massive deterioration by trapping dust particles from the atmosphere and thus increasing the rate of soiling which later aided the development and establishment of plants which could grow into bigger plants if left unchecked. The presence of moss and algae increases water retention and blocks gutters and pipes leading to further damage on historic structures.

5.3.2 Humidity

Humidity is the amount of water vapour or moisture in the atmosphere available around buildings, other structures and even around materials used to put up the structures. Humidity levels or amount of moisture in buildings and other such structures depends on the environment where these building are erected. The amount of moisture on historic building depends on the elasticity of the construction materials in absorbing moisture from the environment. The presence of moisture on immovable cultural heritage including historic buildings, ruins, and the like contributes significantly to the continued reduction of service life of the monuments.

The historic buildings built along coastal areas in Tanga region are overwhelmingly affected by humidity, which causes dampness on construction materials thereby enhancing the rate of deterioration. The relative humidity of Tanga Airfield, representing the Tanga coastal area, attains maximum values of above 90% in the early hours of the *day and does* not go below 60% during the day. Although excessive moisture is prevalent during the rainy months, the effect of sea breeze on the Tanga coastal areas makes it vulnerable to abundant moisture levels almost throughout the year.

These levels of humidity or moisture provide the level of dampness needed for fungus, lichen and even plants to grow. They also provide the best environment for mould, bacteria, mosses and lichen growth. These cause massive deterioration of buildings by producing acids which react with the construction materials providing a suitable environment for plant growth (Feilden 1982; 131). In Tanga fungus growth on wooden structures is easily recognized by discoloration of wood which changes into brownish or whitish colour depending on the type of fungus. Metals were also used as construction materials in some of the buildings. These metals corrode extensively as a result of high content of moisture.

Generally, most of the immovable cultural structures in Tanga are built out of coral stone and lime, as such they have been observed to be very succeptible to dampness in comparison with materials used to put up modern concrete buildings. The coral stone and lime are porous or permeable due to their texture. Cement used as mortar in modern concrete buildings is rather impermeable due to palazzone material. Humidity or moisture on historic buildings provides the suitable environment for bacteria, fungi, algae, lichens moss and higher plants to survive.

A greater number of immovable cultural heritages like ruins were highly affected by moss, lichen, algae and plants. These produce organic acid, which corrodes construction materials like stones. Plants growing on most immovable cultural sites cause destruction by roots which penetrate through the construction materials and cause cracking and sometimes collapse of some parts of the sites.

5.3.3 Wind

Wind is literally air in motion. Differential solar heating and therefore differential atmospheric pressure bring about wind. Direction, speed, gustiness and frequency of calms are important characteristics of wind. According to Feilden (1982; 112) most of coastal areas may expect mean winds of up to 97km/h gusting at times to 62 km/h during rainfall seasons and particularly at time of severe storms. Wind causes destruction to buildings and other structures. Its effect on immovable cultural heritages like historical buildings can be immense as it can lift off sheets or tiles making up roofs covering such buildings.

The other aspect of wind is that it is an agent, which transports a lot of salt moisture onshore or from source. The salts have adverse effect to buildings and other structures including immovable cultural heritage. On reaching such historical sites wind causes tearing, wearing, erosion and peeling of plaster and paintings on walls due to the rapid evaporation which causes crystallization to take place within the walls. Wind combine with sand and dust causes abrasion or attrition on the walls of immovable cultural heritage. Wind associated with rainfall cause serious problems when penetrating cracks, fissure or porous material causes collapse of walls and buildings easily.

5.3.4 Rainfall

The deterioration of immovable cultural heritages along the coast of Tanga may dwindle considerably due to direct rainfall and particularly acid rains falling on these structures. It depends on permeability of construction materials used to put up the structures. The ruins and defensive wails of Tanga are exposed directly to rainfall, which have been raining on them for several decades. There is no doubt that the rains have caused decay by direct penetration of water on their respective walls. Almost all the ruins, defensive walls and Persian buildings built between 12th to 13th centuries were built using limestone as mortar. Limestone is primarily very porous. It allows rainwater to penetrate easily in comparison to modern buildings which are constructed materials using granite rocks.

Direct penetration of rainfall causes dampness on construction materials and this results into peeling off of walls on immovable cultural heritages in Tanga. This is so significant during the alternate cycle of dryness and wetness due to the consequences of direct sunlight or solar radiation, which makes the walls fragile due to expansion and contraction. Direct rainfall on the other hand, causes carbonates of calcium and magnesium to slowly dissolve into the structures resulting in peeling off of wall plaster.

Direct rainfall also provides a conducive environment for plant growth. When rainfall comes into contact with polluted atmospheric oxides like sulphur dioxide and nitrogen oxides, they tend to combine and form weak acidic rain which on falling on immovable cultural heritages, causes the wall plaster and paintings on such structures to peel off. These weak acids slowly dissolve the carbonates from magnesium and calcium on the structures (Torraca 1982;38-40) leading to further deterioration.

The emission of sulphur dioxide and nitrogen oxides leads to a global problem of acidification. Acid deposits affect most construction materials to some degree. Limestone, marble and sandstones are particularly vulnerable while granite based rocks are resistant to rain water. The effect of acid deposition on modern buildings is considerably less damaging than its effect on ancient buildings. Limestone and carbonate stones which are most vulnerable to corrosion were used in ancient buildings unlike new buildings where cement is used as mortar. Limestone and carbonates are more porous and therefore more susceptible to deterioration

Acid rain also contributes to the corrosion of metals. Metals like iron were used to a great extent as construction materials in German and British historical buildings. Corrosion of iron materials, which is embedded in buildings, depends on the position where it is used in the building itself. It takes time, may be years, for iron embedded in beams to corrode since the corrosion depends on access of water to the beam. Corrosion occurs when water and oxygen penetrate into the walls and eventually to the beams. These are used in structures as reinforcement materials. Thus when corroded iron becomes weak and as a result the beams or walls bend or collapse. Historical buildings roofed with iron or aluminium sheets along the coast of Tanga deteriorate very fast due to acid rain or salt water.

This chapter has discussed the effect of climate on immovable cultural heritage along the coast of the coast of Tanga. It gives a general assessment of the role of climatic factors in the deterioration of cultural materials. The following chapter presents the conclusion and recommendation on findings.

Chapter Six

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The potential threat of immovable cultural heritage along the coast of Tanga is climate. Historic buildings have been subjected to deterioration due to climatic variation, which includes, rainfall, temperature, humidity and wind. Immovable cultural heritage undergoes deterioration process when exposed to destructive environmental factors and the rate and symptoms may vary depending on location and materials used for construction. The climate of a place determines the rate and type of deterioration on immovable cultural sites. The project has explored the effect of climate in deterioration of immovable cultural heritage along the coast of Tanga. This includes historical buildings including defensive walls, ruins, Persian buildings, German and British buildings, commercial buildings and memorial landscapes which were established before and during the colonial era.

Apart from the climate, the second important factor which contributes to the deterioration of immovable cultural heritage is aging. This especially is immovable cultural heritage built between the 9th century and the 13th century, like defensive walls and ruins. Human beings also played a role in destroying immovable cultural heritage through vandalism or poor policies on the protection of immovable cultural heritage. Although aging and human beings play a role in the deterioration of immovable cultural heritage along the coast of Tanga, a large part of immovable cultural heritage deteriorate due to climatic condition. Climatic conditions are the primary cause of deterioration of immovable cultural heritage along the coast of Tanga either directly or indirectly. Directly through decay, rotting, cracking, splitting, corroding and peeling off of wall plaster on historic buildings. In some cases wails of some of the historic buildings had collapsed due to climatic condition. Indirect climatic conditions provide a favourable environment for biological agents to survive and cause destruction on immovable cultural heritage. This is mainly due to the fact that climatic conditions along the coast provide a better environment for the biological agents to develop or multiply rapidly.

6.2 Recommendations

6.2.1 Regular maintenances

Most of the immovable cultural heritage along the coast of Tanga were not in a good condition especially the historical buildings and monuments. This was due to climatic fluctuations which cause the destruction. The historic buildings have been subjected to climatic conditions, including, heavy rainfall, high temperature, fluctuating humidity and strong wind. It is therefore imperative that, regular renovation and frequent site inspection on site condition be conducted to check unwanted plant growths and insect attack on buildings.

6.2.2 Local Community awareness.

Through this study it was observed that some of the buildings are in bad and unacceptable condition. This is due to the lack of regular maintenance. In the case of Tanga region the communities have already realized the importance of conserving the immovable cultural heritages. They have started a programme of carrying out renovations of their buildings through Urithi, an NGO (Non Governmental Organization). Although this NGO exists in Tanga to take care of historical buildings there still is an urgent need for the government to involve investors who are capable of running and managing these heritage sites jointly. It is difficult for the government to manage and promote all the sites on its own due to financial constrains.

Tanzania has a lot of immovable cultural materials ranging from prehistoric to historic period. These materials have great cultural value and message to the local communities that live around them. They were the ones who designed, built, painted, used and lived in or around them. Therefore there is a need to involve the local community in the entire conservation and protection processes, so as to get their support and if possible to share the benefits.

6.2.3 Future Research Prospective:

This project has isolated the causes of deterioration of immovable cultural heritage along the coast of Tanga. Conservation of these immovable cultural materials is important for posterity. The research results will help the management to take the necessary action including policy formulation for the conservation of the immovable cultural heritage, which includes all historical buildings, landscapes, and the like.

The research study covers only the climatic- condition which lead to the deterioration of immovable cultural heritage along the coast of Tanga. Further researches should be carried out to establish the role of human beings in the deterioration of immovable cultural heritage along the coast of Tanga so as to know the factors causing the deterioration of immovable cultural heritage.

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Appendix 1: Documentation form

SITE DOCUMENTATION FORM

A. NAME

1. Site Name
2. Local Name
3. Meaning of the Local Name.

B LOCATION

1. Coordinates
2. Village
3. District
4. Region/Province
5. Dimensions/Estimated area
6. Elevation
7. Boundaries

C. HISTORY/BACKGROUND

1 .Historical information

2.Age.

D. SITE INTERPRETATION/PRESENTATION

1. Site type

Ruinsj | Historical Building Rock Art Archaeological Site | |

Historical Site Monument

Other type....

2. How it was known

Research Survey Discovery

Others ways.

3. Community Involvement/Participation.

4. Site Constitution. (Structures, Buildings, Monument, Rock paintings, Flora, Fauna or Archaeological remains)

E. SITE OWNERSHIP

1 .Previous Ownership; Communal Private Government/state

2. Current Ownership; Communal [___J Private Government/state

3. Status; Declared /Gazetted Registered Reported

F. DESCRIPTION OF THE SITE

1. Condition of the site
   Good Fair Bad

2. Research Potentials

3 Potential threats

- Biological....
- Natural
- Human being

4. Conservation works

5. Accessibility to the Site

G. SIGNIFICANCE OF THE SITE

1 .Cultural significance

2.Natural significance.

H. UTILIZATION OF THE SITE

1 .Original use of the Site

2.Current use

3.Future plan/Recommendation

L DOCUMENTATION

Documentation of the site

1 .Photographs/Slides

2.Drawings

/.Sketches

3.Written materials: Publications Bibliography Papers

Letters

4.Audivisual Materials;

Videos/Cassettes

J. RECORDER

1 .Recorder Name

2-Occupation

3.Date

4.Signature

END

Appendix 2: Sites, where research study carried out

NO	TYPE OF THE SITE/BUILDING	NO	NAME OF THE SITE	DISTRICT	STATUS
1.	Defensive walls	1.	Chongolian	Tanga	C
		2.	Monga	Tanga	C
		3	Kizingani	Tanga	C
		4	Kichalikani	Tanga	C
		5.	Kwale	Muheza	C
		6	Mwarongo	Pangani	C
		7	Pangani	Pangani	C
2.	Ruins (Tombs and Mosques)	8	Tongoni	Tanga	C
		9	Chongolian ruins	Tanga	C
		10	Kwale	Muheza	D
		11	Ndumi	Muheza	D
		12	Mwarongo	Pangani	C
		13	Pangani ruins	Pangani	C
3.	Swahili/Arab Historical building	14	Bohora building	Tanga	C
		15	Bohora Mosque	Tanga	B
		16	Khanjibai Building	Tanga	C
		17	Pangani slave building	Pangani	C
4.	German Historical buildings	18	Cliff block (Bombo hospital)	Tanga	C
		19	Elimu building	Tanga	B
		20	Usambara court	Tanga	B
		21	Tanga Boma building	Tanga	C
		22	Former Regional block	Tanga	C
		23	Former Tanga Sec. School	Tanga	C
		24	Kaiserhoff (Tanga hotel)	Tanga	C
		25	German Postal office	Pangani	C
		26	Pangani Boma	Pangani	C
		27	Tanga Railway coperation	Tanga	B
		28	Tanga Harbour	Tanga	B
5	British	29	Tanga library (King)	Tanga	A
		30	Mkonge Hotel	Tanga	A
6	Landscape areas	31	Ambani caves	Tanga	A
		32	Amboni hot/sulphur spring	Tanga	A
		33	Tanga German tower and landscape	Tanga	B
		34	Pangani Germani graves	Pangani	C
		35	German second world war Memorial	Tanga	B
		36	British Second World War Memorial	Tanga	B

A = Good. C = Bad. B = Fair. D = Unacceptable.

Appendix 3: Mean monthly Temperature

Year	Jan	Feb	Mar	Apr	May	Jun	Juyl	Aug	Sept	Oct	Nov	Dec
1971	27.4	27.7	27.8	27.1	25.6	24.3	23.9	23.2	24.1	25.7	27.1	27.7
1972	27.6	27.6	28.3	27.7	25.5	25.2	24.4	24.5	25.1	25.9	26.7	27.5
1973	27.7	28.4	29.0	27.4	26.1	24.9	22.6	22.5	22.9	23.7	24.7	25.0
1974	27.7	26.8	27.5	27.1	25.1	24.9	24.1	24.2	24.2	25.1	26.7	28.2
1975	27.8	28.5	29.0	27.2	26.3	25.3	24.5	24.2	24.5	25.1	26.8	27.5
1976	27.8	28.7	28.5	26.9	26.0	24.9	23.9	24.2	24.8	25.8	27.5	28.6
1977	27.9	28.4	28.4	27.0	26.5	25.3	25.0	24.5	25.0	25.6	26.6	27.3
1978	27.9	28.0	27.8	26.6	26.2	25.5	24.5	24.7	25.5	26.4	26.9	27.2
1979	27.9	28.1	28.3	27.3	25.9	25.2	24.4	24.5	24.7	26.1	27.3	28.2
1980	27.9	28.5	28.7	28.5	26.9	25.5	24.9	24.4	24.8	26.5	27.3	27.8
1981	27.9	28.7	27.9	27.2	26.2	24.9	24.6	24.5	24.7	26.1	27.2	27.2
1982	27.9	28.6	28.7	27.1	25.6	25.2	24.4	24.3	24.8	25.8	26.9	28.2
1983	28.0	28.7	29.4	27.9	26.6	25.9	25.2	24.9	25.1	25.9	27.7	28.0
1984	28.0	28.0	28.5	27.8	26.2	24.7	24.1	23.7	24.2	25.7	26.3	27.4
1985	28.0	27.2	27.8	27.2	25.7	25.0	23.9	24.0	24.4	25.0	26.3	27.3
1986	28.0	27.9	27.9	26.7	26.0	24.8	24.3	24.2	24.7	26.7	27.2	27.8
1987	28.1	28.4	29.5	28.5	26.3	25.3	24.9	24.6	25.3	26.3	27.2	28.3
1988	28.1	29.2	29.3	27.4	26.4	25.0	25.5	24.7	24.6	25.9	26.7	26.9
1989	28.2	27.5	27.6	26.6	25.5	24.7	24.2	23.4	24.5	25.4	26.3	27.5
1990	28.2	27.5	27.5	27.0	26.6	25.1	24.2	24.2	24.9	26.1	26.9	27.7
1991	28.2	28.0	28.5	27.7	26.0	25.0	24.4	23.9	24.5	26.1	26.9	27.1
1992	28.3	28.4	28.5	27.2	26.2	25.1	24.0	23.6	24.2	25.5	25.9	26.5
1993	28.4	27.5	27.9	27.1	25.9	24.8	23.9	23.8	24.2	25.8	26.9	27.5
1994	28.4	27.9	28.6	27.1	25.8	25.3	24.3	24.7	24.8	26.6	26.4	27.3
1995	28.4	28.2	28.4	27.3	25.9	25.3	25.1	24.7	25.0	26.3	26.6	27.8
1996	28.5	28.8	28.6	27.4	26.0	25.5	24.6	24.1	24.7	25.8	26.9	282
1997	28.5	27.8	28.7	27.3	26.0	25.4	24.8	24.9	25.4	25.7	27.0	27.4
1998	28.6	28.6	29.0	28.0	27.0	25.7	25.2	25.0	25.6	25.8	26.9	28.0
1999	28.6	28.8	28.6	26.9	26.0	25.0	24.3	25.0	25.0	25.4	26.8	27.5
2000	28.7	28.1	28.6	27.4	26.1	24.8	24.3	24.4	24.8	25.9	27.7	28.1
Mean	**28.1**	**28.1**	**28.4**	273	**26.1**	**25.1**	**24.4**	**24.2**	24.7	25.8	26.8	27.6

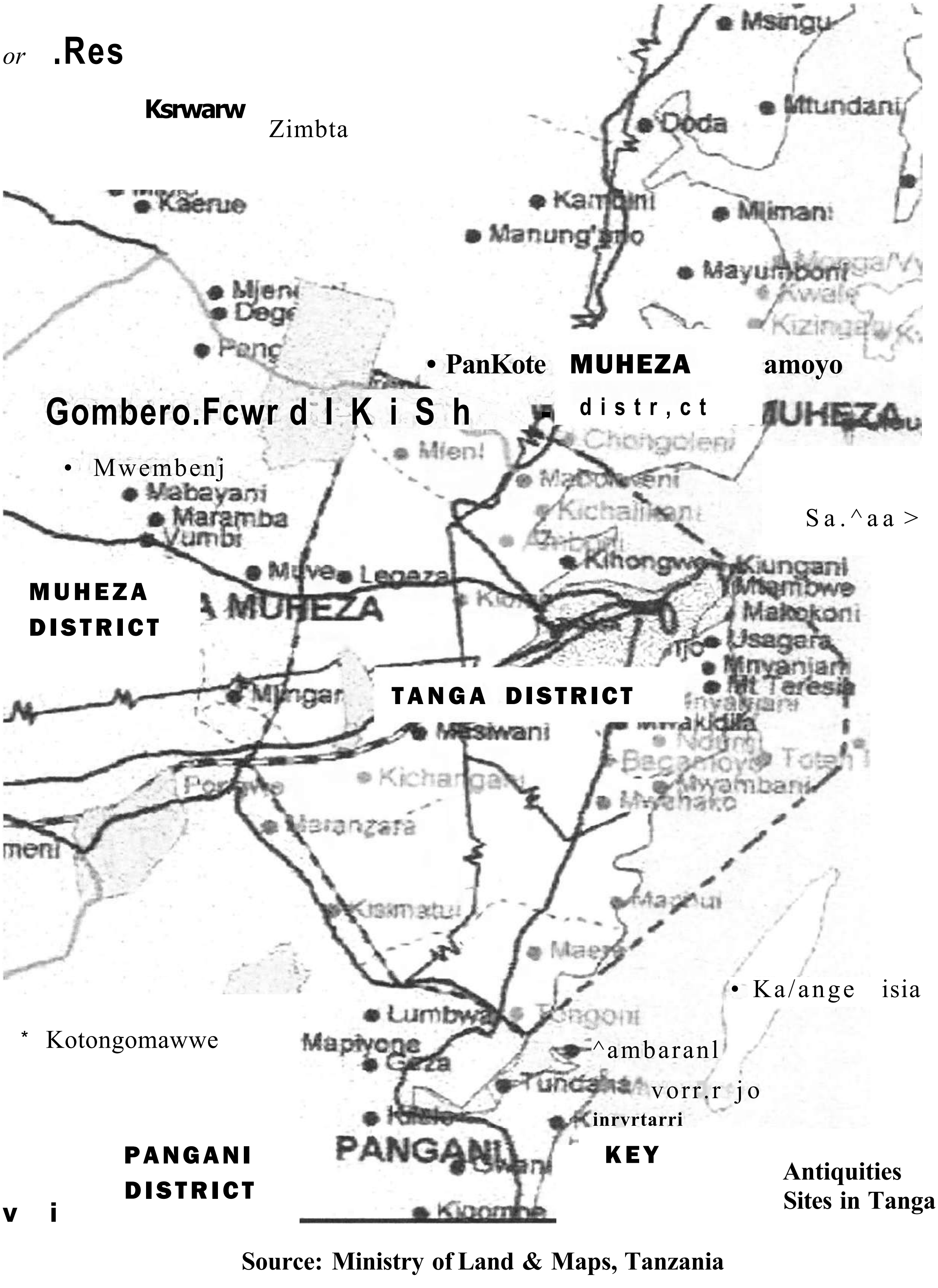
Source ; Tanzania Metrological Agency

Appendix 4: Mean monthly Rainfall

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1971	16.4	0	177.8	44.5	143.2	202.1	52.3	39.3	46.6	18.6	10.4	32.1
1972	89.2	38	44	82.7	587.7	3.5	73.5	18.3	141.9	195.2	247.6	51.7
1973	9.7	68.7	36.4	302.4	273.5	102.4	13.9	81	40.5	70.1	95.2	137.3
1974	9.4	68.7	36.4	302.4	273.5	102.4	13.9	81	33.3	70.1	95.2	137.3
1975	10	0.3	25.1	155.9	177.9	26.8	60.4	12.3	90	75	18.5	107.9
1976	16	15.9	89.6	316.2	321	96.7	74.7	37.1	81.2	37.3	16.6	5.8
1977	6.4	13.9	95.3	190.9	105.5	54.9	15	100.5	192.9	331.4	166.7	161.5
1978	38.8	32.4	212.2	539.9	152	32.1	50.9	32	31.9	57.8	396.8	109
1979	97	96.6	79.7	108.2	642.9	189	40	57.6	1012	68.8	70.9	62.8
1980	24.3	16.2	18.4	215.9	77.3	10.5	67.4	156.1	42.9	14.5	80.3	81.1
1981	39.2	0.4	335.6	119.6	245.9	43.3	36.8	83.7	67.4	174.8	24.8	167.5
1982	4.9	0.2	133	232.4	433.7	157.7	141.7	62.1	138.9	303.3	207	19.1
1983	19.8	7.3	53.8	154.9	490.1	68.4	76.5	30.8	47.4	18.1	7.3	67.1
1984	0.7	0	57.6	459.6	112.9	123.4	1062	29.6	86.7	1592	180.6	93.4
1985	37.3	94.5	130.7	150.1	408	46.8	139.4	106.3	67.4	109.8	124.2	87
1986	40.2	0.1	221.3	353.9	489.3	45.5	17	50.1	37.8	41	169.1	122
1987	37.2	2 2	19	171.8	710.4	25.6	42.3	193.9	39.1	72.1	57.9	72.8
1988	74.6	14.2	36.1	255.7	163.7	247.3	33.5	47.4	90.2	81.6	126.4	136.6
1989	115.6	0	76.4	199.7	213.9	49.4	30.2	120.7	43.4	184.7	150.2	120.2
1990	36.6	134	251.4	344.8	124.2	61.7	12.6	36.5	35.9	45.1	101.6	89.5
1991	83.4	0	162.7	114.3	308.6	54.1	55.2	166.1	18.2	48.1	127.6	99.6
1992	7.8	1.2	7.2	316.6	351.1	73.5	51.7	42.8	62.3	36.8	375.1	87.5
1993	34.6	8.5	22.8	255.3	196.7	65.8	19.9	65.7	48.1	68.5	116.1	146
1994	1.4	85	161.4	311.9	217.9	47.1	115.7	60.3	140.6	91.9	214.3	242.2
1995	0.4	3.8	89.8	320.5	227.8	8.6	49.1	105.9	47.6	133.7	159.8	72.2
1996	5.3	86.2	66.3	157	4382	18.2	30	82.7	30.8	30.5	63.5	1.5
1997	0	1.7	96.4	291.3	177.2	128.6	13.7	57.3	36.7	814	260.7	82.4
1998	183.5	103.4	140.4	564.5	223.6	58.1	55.6	23.3	80.3	35.4	115.4	11.9
1999	5.5	8.8	209.8	252.8	267.3	149.4	106.8	110.1	60.1	71.3	102.7	8.6
2000	0	0	112.2	182.4	184.3	266.1	71.9	44.1	33.8	46.9	114.2	44.9
Mean	**34.8**	**30.1**	**106.6**	**248.9**	**291-3**	**85.3**	**55.6**	**71.2**	**67.2**	**116.9**	**133.2**	**88.6**

Source ; Tanzania Metrological Agency

Appendix 5: Research Sites.



Source: Ministry of Land & Maps, Tanzania